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Soil Losses From Cultivated Strips in Strip-Cropped Fields in the Ohio Valley Region

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INTRODUCTION

Though strip cropping is a practice sufficiently flexible to permit adaptation to many types of agriculture, in the Ohio Valley Region[2] it usually consists of alternate contour strips of cultivated row crops and close-growing crops. The close-growing crop is generally a grass-legume meadow.

One of the functions of the meadow strip is to retard run-off and catch any soil eroded from the cultivated strip. Observations in this region indicated that under some conditions little or no soil had moved from the cultivated strip. Under other conditions, large colluvial fans had accumulated in the meadow strip. Some of these colluvial fans were of sufficient size and extent to indicate that there had been continuous severe erosion from the cultivated strip, and in consequence the quantity of vegetation in the meadow strip had decreased and its quality had deteriorated. The volume and distribution of the colluvial fans appeared to be affected by variations in physiographic, pedologic, and agronomic factors.

[1] The Agronomy Division and the Conservation Experiment Stations Division, Soil Conservation Service, and the Ohio Agricultural Experiment Station cooperated in this study.

[2] The Ohio Valley Region, an administrative unit of the Soil Conservation Service, comprises Michigan, Indiana, Ohio, Kentucky, and Tennessee.

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It is questionable whether satisfactory control of erosion can be considered to have been obtained on a strip-cropped field if a considerable quantity of soil continues to erode from the cultivated strips, even though it is deposited in the meadow strips.

Preliminary investigations on strips near Zanesville, Ohio, during the late summer of 1936 indicated that the volume of the colluvial fans could be measured and associated with such factors as soil type, subsoil characterictics, length of contributing watershed above the strip, slope of strip, deviation of the strip from the contour, cultural practices, and land use on the watershed above the strip.

The following method was devised for measuring the volume of the colluvial fans and relating that volume to associated factors.

METHOD

Plotting Strips and Colluvial Fans

The elevation of the edges of the cultivated strip was plotted on cross-section paper. Deviation from the contour and the vertical slope of the strip were determined with an Abney level placed on a 10-foot straight edge. The length and direction of each deviation from the contour were measured and plotted, as shown in figure 1. The width of strip and elevation of the strip were plotted to suitable scale. The upper edge of the strip represents the vertical rise, which was computed from the percentage slope and the width of the strip. The percentage of deviation from the contour and the length of strip over which the deviation from the contour occurred were likewise represented by vertical rise or fall of the strip edge. The chart so plotted represents a vertical view of the strip with the eye level at the lower edge.

The extent of each colluvial fan was measured as accurately as possible with a steel tape, and the configuration was plotted along the lower edge of the strip.

The strips were divided into sections, each of which includes one or more drainage areas. The method of dividing a strip is shown in figure 1, where the lines LN and OM represent divides of miniature watersheds. Each section in a strip is a part of that strip from which the soil in one or more colluvial fans was derived. The colluvial fan in figure 1 was derived from the off-contour portion of the strip LNOM. Such a division of the strip permits the association of the colluvial deposits with the factors affecting erosion in any section. By grouping the sections of like degree of adherence to the contour, slope of strip, width of strip, and so forth, a sufficient number of samples was obtained in some groups to permit correlation of soil losses with these variables.

Depth of Colluvial Fans

The depth of the colluvial fans was determined at frequent intervals by removing a clod or digging a hole with a large pick mattock and identifying the demarcation between the old surface and the colluvium. These depths were suitably noted on the charts

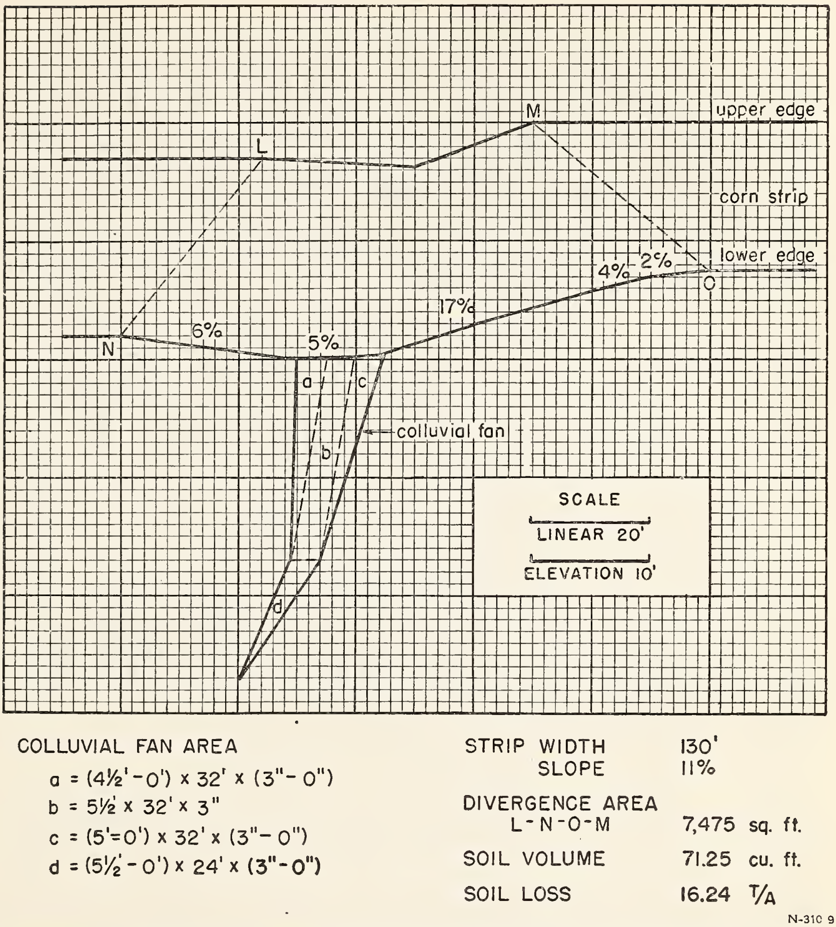

FIGURE 1.—A portion of a field sheet showing graphically an off-contour section of a corn strip.

in the field. Several features helped to identify the contact between the colluvium and the old surface. A distinct stratification of the colluvial fan was often evident and served to identify the depth of the colluvium. The most satisfactory means of determining the demarcation between the colluvium and the original topsoil, however, was the identfication of the buried layer of old vegetation or vegetal debris.

If measurements are properly timed, soil losses for a given period of precipitation may be determined by the foregoing method. If a dry period of sufficient length occurs between the summer rains and the equinoctial storms late in September, many seedlings become established on the surface of the colluvium. Soil eroded from the cultivated strip by autumnal rains covers these plants, and the amount of soil thus added to the colluvial fan can often be determined with a fair degree of accuracy.

Field-Record Sheets

Observations during 1936 indicated that most of the colluvial fans could be classified geometrically. Pyramids or wedges were the most common, though other polyhedra were frequent. In 1937 and 1938 measurements were made by the same procedure used in 1936 except that the manner of recording the field data was simplified. This simplified method was used to record all data obtained in 1937 and 1938, a discussion of which is presented in this circular.

Although some precision was sacrificed by this change in method, it is believed that sufficient accuracy has been achieved. The sim-

EVALUATION OF SOIL MOVEMENT ON STRIPS

Farm F.M.L. Strip No. 3b

Width of strip 84' Crop Corn Date 9-17-1937

Soil type Musk. s.l. Prev. Erosion 3

Soil Deposit						Contour Divergence					Watershed above strip				
Station		Length	Width	Depth	Cubic feet	Station		Width	Per cent	Strip Slope - %	Length	Slope - %	Cover Kind	Cover Quality	Remarks Measured from Left to Right
0	66	0	66	0	—	0	33	33	↘5	13	250	17	P'	P	
66	107	72	41	.66	324.7	33	75	42	↘17				M²	G	
107	132	0 ·	25	0	—	75	115	40	↙6						
132	178	72	46	.84	463.7	115	153	38	↘15						Off Contour > 4%
178	221	0	43	0	—	153	216	63	↙10						
221	271	32	50	.14	37.3	216	271	55	↙4						
271	370	30	99	.10	148.5	271	291	20	↘1	14					Wedge
370	449	8	79	.10	31.6	291	400	109	↙4						Wedge
449	491	24	42	.16	26.9	400	491	91	0						On Contour < 4% Off
491	543	19	52	.48	79.0	491	543	52	0						
543	563	19	20	.14	26.6	543	593	50	↙3						Wedge
563	593	10	30	.30	15.0	593	600	7	0	14	169	17			
593	600	0	7	0	—										

Off Contour Portion = 825.7 Cu. Ft. = 33.0 Tons; 84 x 271 = 22,764 Sq. Ft. } = 63.0 T/A

On Contour Portion = 327.6 Cu. Ft. = 13.1 Tons; 84 x 329 = 28,836 Sq. Ft. } = 19.7 T/A

Figure 2.—Reproduction of a field sheet from the studies made in 1937.

plified method has the advantage of greatly increasing the number of measurements that can be made in 1 day, and it requires less technical skill than the procedure used in 1936.

The data collected in 1937 and 1938 were tabulated on special field sheets, which were so ruled that each column or group of columns contained all figures necessary for computing the value of each factor considered in this investigation. Figure 2, which is a reproduction of a field sheet from the records for 1937, illustrates the method of recording the data. The data on this sheet have been plotted to scale in figure 3 to assist in the interpretation of the field sheet and to indicate that data recorded by the simplified method can be used to make a chart similar to that plotted from data obtained by the method employed in 1936.

Under the heading "Soil deposit" are six columns, the first two of which provide for recording the position of the lateral margins of the colluvial deposits with reference to an arbirtrarily established zero station, usually located at one end of the strip. The figures in

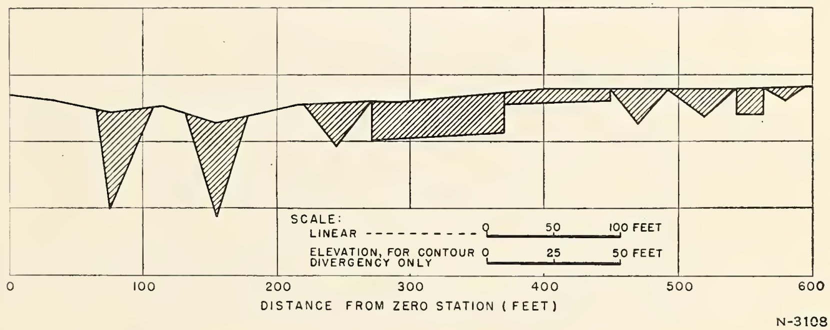

FIGURE 3.—Lower edge of cultivated strip, along which is shown the contour divergence of the strip and the associated colluvial fans. Prepared from data from the field sheet in figure 2.

the fourth column, which are the differences between those in the first two columns, show the width of the colluvial fan along the edge of the strip or the distance between colluvial fans. In the third column the length of the colluvial fan is recorded. A cipher is placed in this column and in the fifth column if no fan occurs below the strip along the interval recorded in the fourth column.

The maximum depth of the colluvial fan, about 1 foot below the edge of the cultivated strip, is recorded in column 5. These data are recorded in hundredths of a foot. Column 6 provides space for recording the calculated volume of soil.

Under the heading "Contour divergence" four columns are provided for recording data on divergence. From the arbitrary zero station previously established, the length of each deviation from the contour is measured. Each change in direction and amount of divergence is determined, and the calculated length of such divergence is recorded in the third column. The direction of the slope of the divergence is indicated by an arrow placed beneath the figure denoting percentage divergence, which is recorded in the fourth column.

The slope of the cultivated strip is determined as often as may be necessary and recorded in the appropriate column.

Four columns are provided under the heading "Watershed above strip." The length of the contributing watershed, the distance from the strip to the farthest point that may contribute run-off to the strip, is measured and recorded at frequent intervals. If strips are carried around a hill, this length may be considerably greater at one end of the strip than at the other. The slope of the watershed above the strip is also determined as frequently as may be necessary and recorded in the proper column. The kind of vegetation on the watershed is recorded by an appropriate symbol, such as M for meadow, C for corn, and the proportion of the whole is indicated by the accompanying numeral. The quality of the vegetation is also shown by symbols.

Under the heading "Remarks" any variation of the colluvial fan from the pyramidal form is shown, the geometrical figure that most closely fits the type of the colluvial fan is sketched, and the values for width and depth of deposit are recorded, as shown in the field sheet (fig. 3).

Volume and Weight of Soil in Colluvial Fans

Since most of the colluvial fans can be classed as tetrahedrons or pyramids of triangular base, the volume of soil can be calculated by the formula

$$\text{Volume of soil} = \frac{\text{Length} \times \text{width} \times \text{depth.}}{6}$$

Appropriate formulas are used for other polyhedral forms. The volume of very irregular fans requires special calculations, and occasionally it may be necessary to plot the fans on coordinate paper in order to determine the volume.

Conversion of the volume of the fan to weight is best accomplished by using an arbitrary factor adapted to the soils for any given area. For the soils in these studies, a factor of 80 pounds per cubic foot was used. Since the textural separates of the colluvial fans may differ widely from those of the soil in the corn strips the volume weight of the soils in these fans may deviate considerably from the weight of the soil in the corn strips. Despite the possible differences in the volume weight of the colluvial fans, variation in slope of strip, contour divergence, length of watershed above the strip, and other influencing factors are associated with sufficient variation in the measurable quantity of colluvium to permit obtaining comparative data without accurately determining the volume weight of the material in the colluvial fan.

Soil in Colluvial Fan Not Total Loss From Strip-Cropped Field

All reference to soil loss or soil movement should be interpreted as indicating only the soil derived from the cultivated strips and accumulated in colluvial fans in the meadow strips. Though measurements of the soil in these fans do not give the total soil loss from an entire field, they furnish a suitable index of the effect on soil loss of the several factors included in this study.

These measured losses from cultivated strips should not be confused with such total soil losses as those from control plots at the soil conservation experiment stations. However, when the vegetated strip is considered as a catchment basin and each cultivated strip as an independent, more or less contour-cultivated plot, a comparison of data from the control plots and from this study is possible.

An estimate of the amount of silt and clay that remained in suspension and was entirely lost from the field can be made by comparing the mechanical analysis of soil samples collected from the corn strips with that of samples collected from the colluvium. That the run-off carries a considerable amount of silt and clay in suspension is certain since many of the soils in these studies were subject to severe sheet erosion rather than gully erosion and since this type of erosion on these soils is predominantly a textural separate form of soil movement.[3] The average differences in mechanical analysis between samples of the surface soil from five strips on Muskingum silt loam and samples of the associated colluvial fans indicated a soil loss as suspended material in the run-off equivalent to approximately 50 percent of the measured colluvium.

A study made by Kohnke and Dreibelbis[4] of some old colluvial deposits of similar soil types indicated that approximately 30 percent of the eroded material had remained in suspension and could not be accounted for in the colluvial deposits.

Some idea of the mineral nutrients that may be contained in the eroded fractions that remain in suspension has been indicated by studies of Scarseth and Chandler.[5] Working with soils in Alabama, they found that the lighter eroded fractions contained 50 to 82 percent of the applied phosphates.

ANALYSIS OF DATA FOR 1936

During the late summer and fall of 1936 measurements were made of soil losses from 2,250 linear feet of strips in corn. All measurements recorded the volume of colluvium in the meadows below the corn strips. The measurements in that year were made primarily to determine the effect of contour divergence on erosion insofar as that was possible without separating out the effect of other variables.

The average soil losses in 1936 from corn strips on a Muskingum silt loam for four contour-divergence classes were as follows:

Soil loss from strips with average contour divergence of—	*Tons per acre*
2 percent	13.0
4 percent	14.5
8 percent	101.0
12 percent	264.0

An inspection of this tabulation indicates that large soil losses were associated with contour divergence above some value between 4 and 8 percent.

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[3] GERDEL, R. W. RECIPROCAL RELATIONSHIPS OF TEXTURE, STRUCTURE, AND EROSION ON SOME RESIDUAL SOILS. Soil Sci. Soc. Amer. Proc. 2: 537–545, illus. 1937. [Processed.]

[4] KOHNKE, HELMUT, and DREIBELBIS, F. R. METHODS OF MEASURING SOIL EROSION. Soil Res. 6: 232–241, illus. 1939.

[5] SCARSETH, GEORGE D., and CHANDLER, W. B. LOSSES OF PHOSPHATES FROM A LIGHT TEXTURED SOIL IN ALABAMA AND ITS RELATION TO SOME ASPECTS OF SOIL CONSERVATION. Amer. Soc. Agron. Jour. 30: 361–374. 1938.

The observations made in 1936 also indicated that soil losses may increase with increase in length of watershed above the strip. For example, a strip above which there were only 60 feet of watershed had a deposited loss of only 20 tons per acre, whereas the evident erosion from a strip with 400 feet of watershed above it was 211 tons per acre. These losses, however, were undoubtedly not attributable solely to length of watershed above the strip.

The results obtained from the preliminary studies in 1936 were considered of sufficient value to warrant continuation and expansion of these studies.

ANALYSIS OF DATA FOR 1937

The simplified method of measuring the soil losses and associated factors was used to obtain data from 15,551 linear feet of strips in corn during the 1937 harvest season. Most of these strips were on Muskingum silt loam of relatively uniform texture; the remainder were on soils of mixed limestone, sandstone, and shale origin, whose composition varied considerably.

The soil losses measured during the field studies made in 1937 and the associated variables are presented in tables 1, 2, and 3. An analysis of these data indicates that on a Muskingum silt loam soil losses materially increased as contour divergence, slope of strip, and amount of cultivated area on the watershed above the strip increased. Large losses occurred where contour divergence exceeded 5 percent. Soil losses were 27.8 tons per acre where divergence from the contour did not exceed 4 percent and 43.7 tons per acre where the divergence from the contour ranged between 5 and 8 percent. The percentage of strips that lost more than 25 tons per acre was almost twice as great if the contour divergence was 5 percent or more as it was if the divergence was less than 5 percent.

Soil losses from strips whose slopes were 18 to 27 percent (65.4 tons per acre) were twice those from strips on slopes between 11 and 17 percent and almost three times those from strips with a slope of 10 percent or less.

TABLE 1.—*Soil losses from strip-cropped fields on Muskingum silt loam, 1937*

Factors affecting erosion	Strips	Average soil loss per acre	Strips having soil loss of—		
			More than 25 tons per acre	10 to 25 tons per acre	Less than 10 tons per acre
Divergence from contour:	*Number*	*Tons*	*Percent*	*Percent*	*Percent*
0–4 percent	21	27.8	33.3	43.2	23.5
5–8 percent	20	43.7	65.0	30.0	5.0
9–18 percent	7	40.8	71.5	28.5	.0
Slope of strip:					
0–10 percent	7	24.0	28.6	14.2	57.2
11–17 percent	32	32.4	50.0	44.0	6.0
18–27 percent	9	65.4	77.7	22.3	.0
Percentage of watershed above strip under cultivation					
None	23	30.1	47.3	39.8	12.9
Less than 50 percent	5	36.0	40.0	60.0	.0
More than 50 percent	6	61.5	83.5	16.5	.0
Length of watershed above strip:					
Less than 100 feet	19	29.3	46.8	37.6	15.6
More than 100 feet	29	45.4	54.4	35.4	10.2

If the watershed above the strip contained more than 50 percent of clean-cultivated crops, the soil loss from the strips was comparatively large. Average losses of 61.5 tons per acre from strips above which more than 50 percent of the watershed was under clean cultivation were double the losses from similar strips below watersheds that were not cultivated.

The data in table 1 also indicate that soil losses from cultivated strips increased as the length of the watershed above the strip increased. However, these data are insufficient to indicate the length of watershed above which supplementary erosion-control practices might be required.

A comparison of soil losses from strip-cropped fields and fields where no control was employed is not possible because there are no data to indicate the loss that might have occurred if these same fields had been entirely under clean cultivation. Whatever such a comparison might show, it appears that satisfactory control of erosion was not always attained with strip cropping.

The soil losses presented in table 2, which are for all strips of 84-foot width on two adjacent farms having identical soil types, further indicate the effect of contour divergence and slope of strip on erosion from cultivated strips. From these data the simple correlation coefficients and the multiple correlation coefficients were calculated, and they are presented in table 3. The multiple-correlation coefficient for soil loss, slope of strip, and divergence is highly significant, owing chiefly to the soil loss contributed by slope of strip. (Compare 0.67 and 0.75.)

Soil losses from only 10 strips on soils of the Westmoreland series of mixed limestone and sandstone origin were measured in 1937. These 10 strips represent 4 different phases of Westmoreland silt loam, which varied not only in the proportion of limestone and sandstone in the parent material but also in their content of silt and clay.

TABLE 2.—*Soil losses per acre from 84-foot strips on Muskingum silt loam as affected by contour divergence and slope, 1937*

Loss where contour divergence was—		Loss where slope of strip was—		
4 percent or less	5 percent or more	0 to 10 percent	11 to 17 percent	18 to 27 percent
Tons	*Tons*	*Tons*	*Tons*	*Tons*
3.6	16.4	16.4	47.0	14.2
2.2	47.0	3.6	22.0	160.8
35.5	22.0	------	20.7	45.7
14.2	20.7	------	2.3	------
33.6	85.4	------	85.4	------
31.1	160.8	------	35.5	------
45.7	54.5	------	33.6	------
12.8	12.1	------	31.1	------
22.7	32.6	------	32.6	------
--------	------	------	54.5	------
--------	------	------	12.8	------
--------	------	------	22.7	------
--------	------	------	12.1	------
Av. 22.4	50.2	10.0	31.7	73.6

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TABLE 3.—*Correlations between soil loss, slope of strip, and divergence from contour on 84-foot strips on Muskingum silt loam, 1937*

Variables	Degrees of freedom	Correlation coefficient
Soil loss and divergence	16	0.34
Soil loss and slope of strip	16	[1].67
Slope of strip and divergence	16	.03
Soil loss, slope of strip, and divergence	15	[1].75

[1] A highly significant value.

Though only a few data were obtained from the studies of strips on Westmoreland silt loam in 1937, there were indications that for this soil the losses varied with slope and contour divergence of the corn strips much as they did for Muskingum silt loam.

Losses from two strips on a Belmont silty clay loam of limestone and shale origin amounted to 124 and 95 tons per acre. The strips, which were 115 feet wide on a slope ranging between 15 and 19 percent, did not diverge more than 7 percent from the contour, and the larger part of the strips adhered to the contour within 3 percent.

ANALYSIS OF DATA FOR 1938

The 187,106 linear feet of cultivated strips, from 6 project and 3 camp areas, on which soil losses were determined in 1938, included 679 samples, each of which consisted of one or more miniature watersheds. This larger number of samples permitted classifying the data into homogeneous groups containing a sufficient number of samples to permit the desired calculations.

SOIL TYPE

As has been shown in a previous paper,[6] most of the soils in this study of strip cropping may be included in four groups according to their erosion potentialities. These groups are: 1, Residual soils with light-textured or permeable subsoils; 2, residual soils with moderate- to heavy-textured or compact subsoils; 3, glacial soils with light-textured or permeable subsoils; 4, glacial soils with moderate- to heavy-textured or compact subsoils.

Use was made of this grouping in this study. Comparisons were made of the difference between soil losses for groups 1 and 2 and between losses for the residual and glacial soils. The grouping of soil types is indicated in tables 4 and 12.

On all measured strips in corn on Muskingum silt loam the average soil loss was only 11.1 tons per acre, whereas that for the strips on Westmoreland silt loam of mixed limestone and sandstone origin was 23.1 tons per acre (table 4). The difference in the amount of soil loss from strips on these two soils can be attributed largely to differences in slope of the strips.

Tests of significance show that for cultivated strips on these two soil types having the same slope of strip, length of watershed above the strip, and contour divergence, the mean difference in soil loss

[6] GERDEL, R. W., and PASCHELL, A. H. GROUPING OF SOIL TYPES TO INDICATE EROSION POTENTIALITIES. Soil Sci. Soc. Amer. Proc. (1939) 4: 372–374. 1940.

is not significant (table 5). Likewise, there is no significant difference between soil losses from corn strips on Hagerstown and Bedford silt loams, also of limestone origin, and losses from strips on Muskingum silt loam in the same slope class, though in different locations.

TABLE 4.—*Average soil losses from cultivated strips on the soil types indicated, 1938*

Soil type	Width of strip	Contour divergence	Slope of strip	Average soil loss per acre	Strips having no measurable soil loss [1]	Strips too severely gullied through the meadow to permit measurement of soil loss [1]
	Feet	*Percent*	*Percent*	*Tons*	*Percent*	*Percent*
Residual soils:						
Muskingum silt loam	64	2.8	15.5	11.1	19.0	20.5
Zanesville silt loam	72	1.3	11.3	4.7		
Wellston silt loam	65	2.4	14.7	13.1		
Tilsit silt loam	58	3.0	14.9	22.4		
Coolville silt loam	75	3.2	15.3	20.9		
Meigs silty clay loam	71	3.1	16.3	15.6		16.4
Westmoreland silt loam and silty clay loam	47	2.9	21.2	23.1		4.5
Hagerstown silt loam	81	2.8	8.9	1.1	41.1	3.9
Bedford silt loam	84	2.5	7.2	4.9	10.4	7.5
Frankstown silt loam [2]	90	1.9	19.1	18.5		
Holston silt loam	73	2.5	12.0	4.2	11.5	
Monongahela silt loam	115	2.3	9.0	2.3		
Elk loam	79	2.0	8.0	0	100.0	
Glacial soils:						
Wooster silt loam	66	2.7	12.1	2.1	66.3	
Rittman silt loam	85	3.1	8.6	2.7	68.3	
Ellsworth silt loam	104	3.5	3.9	4.1	13.9	
Cardigan silt loam	73	2.8	8.3	2.7	40.6	
Miami silt loam [3]	78	2.2	6.6	.3	33.5	10.6
Russell silt loam	100	3.3	5.3	1.8	28.0	7.1
Fincastle silt loam	84	2.5	4.5	1.9	42.2	
Chenango loam [4]	79	3.1	7.0	2.4	55.0	

[1] Percentage of linear feet of the strips measured.
[2] Frankstown silt loam consists of a predominantly sandstone-shale soil that contains sufficient flint to give a surface color and subsoil texture different from the usual Muskingum of the area.
[3] Miami silt loam includes a small amount of Bellefontaine silt loam.
[4] Includes some Morainic Wooster.

TABLE 5.—*Significance of difference in soil losses from corn strips between several pairs of residual soils and between residual and glacial soils; contour divergence 0 to 4 percent, 1938*

Soil types	Slope of strip	Length of watershed above strip	Samples	Soil loss per acre: Average	Soil loss per acre: Mean difference	t	Degrees of freedom	Significance of mean difference
	Percent	*Feet*	*Number*	*Tons*	*Tons*			
Muskingum silt loam Westmoreland silt loam and silty clay loam	15–24	100–299	32 20	13.23 12.97	0.26	0.250	50	Not significant.
Muskingum silt loam Westmoreland silt loam and silty clay loam	20–24	100–299	12 10	13.79 19.53	5.74	1.565	20	Do.
Muskingum silt loam Hagerstown and Bedford silt loam	5–9	0–99	12 12	3.36 1.27	2.09	1.788	22	Do.
Muskingum silt loam Wellston, Coolville, Tilsit, and Meigs silt loam	20–24	100–299	12 7	13.79 33.39	19.60	4.166	17	Highly significant.
Residual soils Glacial soils	5–9	100–199	8 21	4.14 .27	3.87	3.110	27	Do.

On the other hand, the Muskingum silt loam and residual sandstone and shale soils with characteristically heavy or compact subsoils, such as Wellston, Coolville, Tilsit, and Meigs, show a highly significant difference in erodibility under strip cropping (table 5). A mean difference of 19.6 tons per acre in the soil loss from corn strips on those residual soils with heavy or compact subsoils and from strips on Muskingum silt loam indicates that strip-cropping plans for these types of residual soils should be measurably different from those for Muskingum, Westmoreland, Hagerstown, and Bedford silt loams.

The difference in erodibility between all glacial soils and all residual soils is also highly significant. Soil losses from cultivated strips on slopes between 5 and 9 percent were only 0.27 ton per acre on soils of glacial origin but 4.14 tons per acre on residual soils. Since this is the only slope class common to both soil groups on which soil losses from cultivated strips could be measured, comparison of losses from strips on steeper slopes could not be made. The large difference between soil losses from strips on glacial and residual soils may be attributed to the difference in the physical properties of these soils, their fertility level, the degree of previous erosion they have undergone, and the farming practices associated with them.

The determination of soil types showing no significant difference in erodibility permitted groupings of larger numbers of strip samples of like erodibility for analysis of the effect on soil loss of factors other than soil type.

Slope of Strip and Length of Watershed Above the Strip

The analysis of the data obtained in 1937 indicated that both the slope of a strip and the length of the watershed above it greatly influence the amount of erosion from that strip. The data, however, were not sufficient to permit the analysis of either of these two variables independently of the other.

A sufficient number of cultivated strips was studied in 1938 to permit the grouping of samples in classes having a narrow range of strip slope and length of watershed above the strip. In each class the watershed above the strip had the same average slope as the strip sample. It was also possible to study these two variables on different soil types grouped according to similar erodibility.

Although it was not possible to classify the strips on glaciated soils according to the length of watershed above the strip, it is apparent from the data presented in table 6 that soil losses from strips on glacial soils are much less than those from strips on residual soils if the strips have corresponding slopes and length of watershed above the strip. It is also apparent that soil losses from strips with similar slopes and with the watershed above the strips of comparable length may be two to three times greater for soils with moderately heavy to heavy subsoil than for soils with light-textured subsoils.

TABLE 6.—*Average soil losses from strips having slopes ranging from 5 to 34 percent and length of watershed above strip up to 299 feet, with contour divergence between 0 and 4 percent, 1938*

Soil group [1]	Length of watershed above strip	Soil loss per acre from strips with slope of—					
		5 to 9 percent	10 to 14 percent	15 to 19 percent	20 to 24 percent	25 to 29 percent	30 to 34 percent
	Feet	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Group 1: Residual soils with light-textured or permeable subsoils.	0–99	3.4	6.6	6.2	12.7	--------	21.2
	100–199	2.9	7.9	13.3	16.0	20.7	33.4
	290–299	3.4	12.7	26.0	37.1	71.2	92.0
Group 2: Residual soils with moderate to heavy textured or compact subsoils.	0–99	--------	13.9	22.3	--------	41.4	--------
	100–199	7.9	22.4	29.5	42.0	--------	--------
	200–299	--------	29.1	--------	--------	116.7	--------
Group 3: Glacial soils with light-textured or permeable subsoils	0–299	.5	1.7	7.4	--------	--------	--------
Group 4: Glacial soils with moderate to heavy textured or compact subsoils	0–299	.7	6.5	19.0	--------	--------	--------

[1] For soil types in each group, see footnotes 1 to 4, table 12.

CONTOUR DIVERGENCE

Data obtained from the studies of strip cropping in 1936 and 1937 indicated that large soil losses from cultivated strips occurred where contour divergence exceeded 5 percent.

An analysis of the data obtained in 1938 (table 7) indicates that the steepness of a strip-cropped slope greatly modifies the effect of contour divergence of the strip on soil loss. As should be expected, considerable divergence from the contour on slopes above 24 percent was associated with much greater soil losses from cultivated strips than the same divergence from the contour on lesser slopes.

TABLE 7.—*Soil loss from cultivated strips on Muskingum silt loam and Westmoreland silt loam and silty clay loam, with contour divergence 0 to 4 percent and 5 to 8 percent, on slopes ranging from 10 to 29 percent, project areas at Zanesville and Cambridge, Ohio, 1938*

Contour divergence (percent)	Slope [1] of strip	Soil loss per acre	Contour divergence (percent)	Slope [1] of strip	Soil loss per acre
	Percent	*Tons*		*Percent*	*Tons*
0–4	10–14	7.1	5–8	10–14	6.0
	15–24	13.3		15–24	15.7
	25–29	18.4		25–29	36.3

[1] Length of watershed above the strip is 100–299 feet.

Average soil losses from strips on Muskingum and Westmoreland soil on 15- to 24-percent slopes with 100- to 199-foot length of watershed above the strip increased as follows with each 2-percent increase in contour divergence:

Soil loss with contour divergence of—	*Tons per acre*
1 to 2 percent	7.0
3 to 4 percent	10.1
5 to 6 percent	14.0
7 to 8 percent	17.4
9 to 10 percent	44.2

These data indicate that soil losses increase at a more rapid rate where contour divergence exceeds 8 percent than where it is 8 percent or less. However, soil losses of considerable magnitude occur even where contour divergence is less than 9 percent.

Although the data from Hagerstown and Bedford silt loams were included in the analysis of the effect on soil loss of the slope of strip and length of watershed above the strip, it was not possible to include the losses from strips on these two soils in the analysis of contour divergence. Where the contour divergence of cultivated strips on Hagerstown and Bedford silt loams exceeded 5 percent, frequent gullies in the lower meadow strip made it impossible to measure soil losses. The quality of cover in the meadows appeared to be too low to retard run-off and prevent gullying.

Width of Strip

Any variation in width of strip between 28 and 84 feet apparently has little effect on soil losses. Reducing the width of a strip apparently will not offset the effect of steep slopes or a long watershed above the strip (table 8). Since there are only a few strips in the Ohio Valley Region wider than 84 feet, and since these are predominantly on the ridge tops, insufficient data are available from which soil losses on strips more than 84 feet may be determined. The fact that variation in width of strips between 28 and 84 feet has no effect on erosion from the strips is further substantiated in the report of the Northwest Appalachian Soil and Water Conservation Experiment Station.[7] At this station very little difference in soil loss was found between strips 35 feet and 70 feet wide and between control plots 36 feet and 72 feet long.

TABLE 8.—*Soil losses from strips 28 to 84 feet wide on Muskingum silt loam and Westmoreland silt loam and silty clay loam; contour divergence 0 to 4 percent, 1938*

Width of strip (feet)	Slope of strip	Length of watershed above strip [1]	Soil loss per acre	Width of strip (feet)	Slope of strip	Length of watershed above strip [1]	Soil loss per acre
	Percent	*Feet*	*Tons*		*Percent*	*Feet*	*Tons*
28–50	15–19	100–199	5.9	51–84	15–19	100–199	7.3
	15–19	200–299	17.7		15–19	200–299	17.3
	20–24	200–299	26.4		20–21	200–299	22.9

[1] The slope of the watershed above a strip is in the same slope class as the strip.

Apparently the use of strips narrower than 84 feet on the longer and steeper slopes will not effect greater control of erosion if the usual 4-year rotation remains unchanged.

[7] BORST, H. L., and WOODBURN, RUSSELL. PROGRESS REPORT OF THE NORTHWEST APPALACHIAN SOIL AND WATER CONSERVATION EXPERIMENT STATION, ZANESVILLE, OHIO, 1933–37. U. S. Soil Conserv. Serv., ESR–8, 58 pp., illus. 1939.

Land Use on the Watershed Above a Strip

An increase in erosion resulting from an increase in the amount of clean-cultivated land on the watershed above the strip is shown by an analysis of the data for 1937. Although only a part of the data for 1938 could be analyzed to determine the relation of soil loss to land use on the watershed above the strip, this variable appeared to have a notable effect.

In the Carrollton, Ohio, camp area the average soil loss was 12.9 tons per acre from strips on Muskingum silt loam if less than 20 percent of the watershed above the strip was clean-cultivated. If more than 20 percent of the watershed above the strip was in clean-cultivated crops, the average soil loss from the corn strips amounted to 40.2 tons per acre.

Analysis of the data from one farm in the Seneca Fork project near Cambridge, Ohio, also shows how soil loss from strips of clean-cultivated crops is affected by the land use on the watershed above the strips. On this farm, where the watershed above the south end of a strip-cropped field was protected by meadow and forest, an average loss of 9.3 tons per acre was measured from all the cultivated strips on the south end of the field. Average soil losses from the north end of the same strips, where there was a cultivated strip-cropped field on the entire watershed above the strips, amounted to 17.3 tons per acre. Since both ends of the field were similar in other respects, it appears that the difference in quantity and type of vegetation on the watershed above a cultivated strip may greatly influence the soil losses from that strip.

Degree of Previous Erosion

Information about the amount of erosion that had occurred in the fields before they were strip-cropped was available from the conservation survey map for nearly all strips in these studies. To offset the effect of possible differences in opinion about correct erosion classification, strips from the Seneca Fork project were selected from the farms under agreement for which most of the conservation survey maps were prepared by one soil surveyor. Strips so selected were studied to determine the effect of previous erosion on soil losses from the strips.

Analysis of these data (table 9) indicates that the amount of erosion that has occurred on a field before it is strip-cropped directly affects the amount of erosion from the cultivated strips. Although soil losses from strips on soils with heavy or compact subsoils were approximately three times as large as those from strips in the same erosion classes on Muskingum and Westmoreland soils (group 1), which have lighter subsoils, on both soil groups there was approximately twice as much erosion on the cultivated strips from which more than 75 percent of the topsoil had been removed before strip cropping than on those from which only 50 to 75 percent of the topsoil had been removed.

TABLE 9.—*Soil losses from corn strips on 10- to 19-percent slopes with contour divergence 0 to 4 percent and previous erosion mapped as classes 33, 337, or 4*

Soil group [1]	Soil loss per acre on strips for which previous erosion [2] was mapped as class—		
	33	337	4
	Tons	*Tons*	*Tons*
Group 1. Residual soils with light-textured or permeable subsoils	[3] 5.8	14.6	[3] 11.2
Group 2. Residual soils with moderate to heavy textured or compact subsoils	[3] 16.5		[3] 35.2

[1] For soil types in each group, see footnotes 1 to 4, table 12.
[2] Erosion class 33=50 to 75 percent of the topsoil removed; erosion class 337=50 to 75 percent of the topsoil removed, with occasional shallow gullies; erosion class 4=75 percent or more of the topsoil removed.
[3] Differences tested by Fisher's method and found to be highly significant.

From cultivated strips on Muskingum and Westmoreland soils (group 1) from which 50 to 75 percent of the topsoil had been removed and on which occasional gullies were present (erosion class 337) soil losses were one-third larger than from strips on which severe sheet erosion alone had removed 75 to 100 percent of the topsoil (erosion class 4).

The larger soil losses from strips in fields having occasional gullies appeared to be due to the lack of a sufficient number of sod waterways or to waterways having insufficient width or an inadequate cover of vegetation. The depth and shape of the gullies may affect the establishment of satisfactory sod waterways and also prevent the attainment of practical contour adherence.

Soil Management

Soil losses from the cultivated strips on two adjacent farms in the Salt Creek project were measured for 3 consecutive years. On these two farms (table 10) the soil losses from cultivated strips decreased as a result of improvement in the soil-management program, the average losses being reduced from 98.3 tons per acre in 1936 to 3.7 tons per acre in 1938. These losses for 1936 and 1938 are measurements taken on the same fields but on alternate strips. Since the measurements for 1937 and 1938 were made in different fields, differences in soil losses could have been due to differences in contour adherence, slope of strip, and length of watershed above the strip. That the total difference in the losses in these years is not attributable to any one or all of these factors is shown by the fact that the difference in losses for 1937 and 1938 from strips having the same slope, contour divergence, and length of watershed above the strip was found to be highly significant when tested by Fisher's [5] method.

An examination of the soil losses from the cultivated strips on these two farms (table 10) in connection with rainfall records obtained from a rain gage on the Gosser farm (table 11) supports the conclusion that by soil management one may decrease the erodibility of a field.

[5] FISHER, R. A. STATISTICAL METHODS FOR RESEARCH WORKERS. Ed. 5. 319 pp., illus. Edinburgh. 1934.

Comparison of the soil losses from these strips with the losses reported from the 72-foot long, unfertilized, rotation corn plots at the Soil and Water Conservation Experiment Station at Zanesville, Ohio,[9] indicates that soil losses were less from the cultivated strips on the farms, where the cultural and fertility programs had been improved during the 3-year period 1936–38. Comparison of rainfall at the experiment station and the Gosser farm for the growing seasons 1936–38 (table 11) does not indicate that the differences in soil losses between these two locations can be attributed to differences in the quantity of rainfall. Variations in duration and intensity may have occurred, but observation indicated that such variation was not sufficient to influence soil losses.

TABLE 10.—*Soil losses from corn strips on two adjacent farms of cooperators in the Salt Creek project and from rotation corn plots at the soil and water conservation experiment station at Zanesville, Ohio*

Year	Lapp and Gosser farm			Experiment station	
	Contour divergence	Rainfall [1]	Soil loss per acre	Rainfall [1]	Soil loss per acre
	Percent	*Inches*	*Tons*	*Inches*	*Tons*
1936	6. 5	18. 61	98. 3	17. 09	54. 3
1937 [2]	4. 2	23. 28	34. 8	19. 40	41. 9
1938 [2]	3. 5	21. 65	3. 7	22. 24	72. 6

[1] Total rainfall for growing season, May to September. Rainfall shown for the farms was measured on the Gosser farm.
[2] For 6 strips from the data for 1937 and 6 from that for 1938 of the same slope, contour adherence, and length of watershed above the strip, $D=20.7\pm5.8$, $t=3.56$, with 10 degrees of freedom. The difference is highly significant.

TABLE 11.—*Precipitation during the growing season at the soil and water conservation experiment station, Zanesville, Ohio, and the H. H. Gosser farm, Salt Creek project*

Year	Location	May	June	July	August	September	Total
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1936	Experiment station	1. 98	1. 37	6. 09	4. 89	2. 76	17. 09
	Gosser farm	3. 09	1. 70	5. 19	4. 76	3. 87	18. 61
1937	Experiment station	4. 55	6. 85	2. 84	3. 63	1. 53	19. 40
	Gosser farm	4. 35	7. 83	5. 78	3. 66	1. 66	23. 28
1938	Experiment station	6. 61	4. 72	2. 43	3. 85	4. 63	22. 24
	Gosser farm	6. 43	4. 64	3. 20	3. 43	3. 95	21. 65

The reduction in erosion from the cultivated strips on these two farms from 98.3 tons of soil per acre in 1936 to 34.8 tons per acre in 1937 and the still further reduction to only 3.7 tons per acre in 1938 reflects not only the improvement in the meadows, which resulted from better soil management, but also the improvement in contour adherence, which was also a part of the conservation program on these farms.

Some slight relocation in strip boundaries was made to correct contour divergence. A large part of this improvement in contour adherence, however, was the natural result of a gradual development

[9] See footnote 8, p. 35.

of the entire strip-cropping program on these farms. Wider sod waterways were left in the draws that dissected these strip-cropped fields when improved meadow strips were plowed down for corn. This greatly reduced divergence from the contour, which had previously resulted from planting corn down the sides of the draws.

Improvement in the soil-management program through the use of lime, fertilizer, and a good grass-legume mixture, with small grain as a companion crop, rapidly improved the meadow strips. By the spring of 1938 an excellent quality of vegetation was plowed down for the corn crop. Although the organic content or fertility level of the soil was not determined, there was an apparent increase in humus and nutrient content in these strip-cropped fields by 1938.

CRITICAL VALUES

Those factors that have been studied appear to be closely interrelated in their influence on soil losses from cultivated strips. The ideal combination of physiographic, pedologic, and agronomic conditions that would result in no evident erosion from cultivated strips is difficult to attain in most parts of the Ohio Valley Region where strip cropping is recommended. Measurable soil loss from cultivated strips may occur on slopes of less than 5 percent even if the contributing watershed above the strips is less than 100 feet long. Contour divergence of less than 2 percent may contribute considerably to erosion under some conditions. Pedological characteristics also affect the amount of soil loss associated with variations in topographic features.

To determine the values of the factors affecting erosion under which strip cropping alone can be considered successful, it is necessary to select arbitrarily some maximum value for soil loss and to assume that soil losses greater than this maximum indicate that strip cropping alone will not satisfactorily control erosion.

In this discussion limits of permissible soil loss have been arbitrarily designated. Values for individual or combined physiographic factors above which soil loss will exceed these limits will be referred to as "critical values."

The critical values can be determined best from the 1938 data, because studies made in 1938 permitted a more detailed analysis of the effect of variations in the several factors. Though the ranges of the physiographic and pedologic factors included in the studies for 1938 was considerably greater than the corresponding ranges in the studies for 1936 and 1937 the data for 1938 do not cover all combinations of those factors included in this study that may affect soil loss from cultivated strips. Sufficient data could not be obtained to permit an analysis of either the effect of watershed lengths greater than 300 feet or the effect of variations in contour divergence for each of the slope-of-strip and length-of-watershed classes in table 6. However, from the data available, it appears possible to determine reasonably accurate critical values for slope of strip, length of watershed above the strip, and contour divergence on several groups of soils commonly strip-cropped in the Ohio Valley Region.

Contour Divergence

If we assume a 10-ton-per-acre maximum soil loss from the cultivated strips as indicative of successful erosion control by the use of strip cropping alone, we may conclude from the results obtained in these studies, that contour divergence in excess of 4 percent on slopes above 14 percent and up to 299 feet in length will result in unsatisfactory control of soil losses on the residual soils in groups 1 and 2. Only on slopes of less than 15 percent were soil losses less than 10 tons per acre when contour divergence exceeded 4 percent.

If a maximum loss of 25 tons per acre is assumed as indicative of successful erosion control by strip cropping alone on residual soils, contour divergence may not exceed 8 percent on 15- to 24-percent slopes, with length of watershed above the strip 100 to 199 feet, or 4 percent on 25- to 29-percent slopes, with length of watershed above the strip 100 to 299 feet. That the critical value for contour divergence falls somewhere between 4 and 8 percent is indicated by the fact that soil losses increase about 100 percent if contour divergence exceeds 4 percent on 25- to 29-percent slopes with length of watershed above the strip 100 to 299 feet and more than 100 percent if the contour divergence exceeds 8 percent on 15- to 24-percent slopes with length of watershed above the strip 100 to 199 feet. In addition, the fact that soil losses were frequently unmeasurable owing to gullying of the meadow strip where contour divergence exceeded 5 percent, even on slopes of less than 15 percent, appears to indicate that for most slopes, cultivated strips on residual soils should not diverge from the contour by more than 5 percent. Divergence in excess of this critical value will usually result in large soil losses and unsatisfactory control of erosion.

Lack of sufficient data made it impossible to determine the critical value for contour divergence on the glacial soils in groups 3 and 4 by an analysis similar to that used for residual soils. However, an anaylysis of data collected in 1939 from strips on glacial soils with light-textured subsoils (group 3) showed that 15 percent of all samples that diverged from the contour more than 5 percent were gullied through the meadow strip, whereas only 3 percent of the samples whose contour divergence did not exceed 5 percent had gullied through the meadow strip. These results indicate the possibility that the critical value of 5 percent for contour divergence may be applied to all groups of soils in this study.

Slope of Strip and Length of Watershed Above the Strip

Although the use of contour strip cropping may decrease soil losses from cultivated fields, erosion from the contour-cultivated strips on steep slopes or slopes with long, unprotected watersheds may still amount to more than 100 tons per acre. Any land use practice that permits such relatively large soil losses to occur, though achieving some reduction in erosion, cannot be considered an entirely satisfactory method of attaining a permanent agriculture.

Critical values for length of watershed above strip and slope of strip for each of the four groups of soils in this study were determined for maximum allowable soil losses of 5, 10, 25, and 40 tons per acre (table 12). These critical values were obtained by interpolation from table 6.

Only within the limits of these critical values may strip cropping be expected to control soil loss satisfactorily. The maximum allowable strip slope and length of watershed above the strip shown in table 12 were selected on the presumption that the critical value of 5 percent for contour divergence will not be exceeded.

It is apparent that strip cropping can be expected to produce satisfactory control of erosion under most of the physiographic conditions that exist on the group of glacial soils included in these studies. On these soils, slopes are rarely greater than 14 percent, and those greater than this are seldom cultivated.

On the other hand, to control erosion satisfactorily on the long, steep slopes on the residual soils in southeastern Ohio and adjacent parts of other States, other practices than strip cropping alone will undoubtedly be required. The critical values for slope and for length of watershed above any given cultivated strip on the residual soils with heavy compact subsoils are frequently less than the slope measurements of fields commonly and necessarily cultivated in this area. Even on the residual soils with light-textured or permeable subsoils, many of these critical values corresponding to maximum soil losses up to 25 tons per acre are less than the values for these physiographic factors common in cultivated fields.

TABLE 12.—*Critical values for slope of strip and length of watershed above the strip, for the four soil groups, corresponding to maximum allowable soil losses of 5, 10, 24, and 40 tons per acre, the assumed critical value for contour divergence being 5 percent*

Soil group	Maximum allowable length of watershed above strip	Maximum allowable slope of strip for soil loss per acre of—			
		5 tons	10 tons	25 tons	40 tons
	Feet	*Percent*	*Percent*	*Percent*	*Percent*
Group 1:[1] Residual soils with light-textured or permeable subsoils	100	9	19	34	34
	200	9	14	29	34
	300	9	9	14	24
Group 2:[2] Residual soils with moderate to heavy textured or compact subsoils	100	9	9	14	24
	200	0	9	14	19
	300	0	0	9	14
Group 3:[3] Glacial soils with light-textured or permeable subsoils	300	19	24	34	----------
Group 4:[4] Glacial soils with moderate to heavy subsoils	300	9	14	24	34

[1] Soil types in this group: Muskingum silt loam, Muskingum silty clay loam, Westmoreland silt loam, Westmoreland silty clay loam, Hagerstown silt loam, Bedford silt loam.

[2] Soil types in this group: Wellston silt loam, Tilsit silt loam, Coolville silt loam, Meigs silt loam, Meigs silty clay loam, Belmont silty clay loam, Upshur clay loam. Insufficient data were obtained for analysis of Belmont silty clay loam and Upshur clay loam, but from data available these soil types appeared to belong to this group.

[3] Soil types in this group: Wooster silt loam, Canfield silt loam, Chenango loam, Chenango silt loam, Braceville silt loam. Insufficient data were obtained for analysis of all soil types in this group except Wooster silt loam. From the data available, however, these soil types appeared to belong in this group.

[4] Soil types in this group: Rittman silt loam, Ellsworth silt loam, Cardington silt loam, Miami silt loam. Insufficient data were obtained for analysis of Miami silt loam, but from data available this soil type appeared to belong to this group.

CONSERVATION PRACTICES SUPPLEMENTARY TO STRIP CROPPING

Where contour adherence satisfactory for desired erosion control is difficult to achieve because frequent draws dissect a slope, the use of wide sod waterways in the draws will aid in attaining contour adherence within the critical limit of 5 percent. The use of sod

waterways of sufficient width does not seriously reduce the cultivable area. In 1939 a study was made of approximately 400 acres of corn strips on slopes with frequent draws in which sod waterways of adequate width were used to achieve a maximum contour divergence of 5 percent. It was found that the total area of the sod waterways included in the cultivated strip was less than 36 acres. This amount represents only a 9-percent reduction in the possible cultivable area of the strips.

As stated previously, variation in width of strip between 28 and 84 feet apparently does not affect soil losses from cultivated strips. The use of narrow strips on steep, irregular slopes, however, may be an effective means of achieving a closer adherence of the strip boundaries to the contour and less variation in width of strips as well as a closer adherence to the contour of the rows in the cultivated strips.

It is possible that diversion ditches could be used to change the effective length of slopes. On one farm included in these studies a diversion ditch was constructed in the fall of 1938 to divert run-off and reduce the length of the contributing watershed above a strip-cropped field. Soil losses from the corn strips in this field in 1937 average 36 tons per acre, whereas the average loss from the corn strips in this same field in 1939, after construction of the diversion ditch, was only 4 tons per acre. Improvement in contour adherence of the strips and in soil fertility, with the resultant improvement in the quality of the meadow strips and humus content of the soil, probably accounted for some of this reduction in erosion. However, all observations indicated that the diversion ditch had contributed materially to this reduction in soil loss.

It was observed during the course of this investigation that high contour ridging of the cultivated row crops decreased soil losses from the cultivated strips. Under practical field operations, however, it is difficult to maintain satisfactory adherence to the contour of each ridgerow. High ridges associated with off-contour rows resulted in concentration of the run-off, which caused scouring between the rows and the deposition of large colluvial fans in the meadow strip where the diverging rows dipped into draws or point-rowed into the lower-lying meadow strip.

Even where corn rows can be maintained on the contour, the use of high ridges may increase the droughtiness of the shallow residual soils and the deep loose sandy soils in years of insufficient or poorly distributed rainfall.

Each of the soil types included in these studies may have had, originally, different crop-producing potentialities. However, the effect of previous erosion and cropping practices has frequently eliminated such differences between the soils in any one group. The use of contour strip cropping and a good soil-improvement program may not result in an immediate difference in the degree of erosion control obtainable on soils within a group. Over a period of time, however, one soil may react more favorably than another to such a conservation program, and those soils that increase most in fertility and organic content will show less erosion when strip cropped than the soils that dot not respond so well to soil improvement.

The control of erosion by use of contour strip cropping was found to be affected by the amount of clean-cultivated land on the watershed

above the strip. It appears, therefore, that the application of erosion-control practices over an entire watershed rather than on single farm units frequently may be necessary for the successful use of strip cropping.

SUMMARY

During the growing seasons of 1936, 1937, and 1938 studies were made of soil losses from cultivated strips on strip-cropped fields in parts of the Ohio Valley Region. Only the soil deposited in the meadow strips immediately below the eroded cultivated strips was measured. The measured deposits were colluvial fans of several polyhedral forms, chiefly wedges and pyramids.

The slope of strip and divergence from the contour were determined for each portion of a strip from which the soil in any colluvial fan had been eroded. The volume of soil in a colluvial fan was measured with the intent of determining the association of that volume with the values for the slope of strip and divergence of contour of the portion of the strip from which the soil in the colluvial fan was derived. Like measurements were made also of the distance from a strip to the top of the watershed contributing run-off to that strip and the width of strip. Soil loss on the different soil types, on strips of different degrees of previous erosion, and on strips below areas in different types of land use were studied in like manner. A few practices supplementary to strip cropping were also studied in relation to the soil losses from cultivated strips.

The measurements made in 1936, on Muskingum silt loam, chiefly to discover relationships between contour divergence and soil loss, produced insufficient data for statistical analysis, but indicated that soil losses increase with increases in divergence from the contour and are excessively large where the contour divergence exceeds 5 percent.

The extension of the study in 1937 to measurements of soil loss from 15,551 linear feet of strips gave sufficient data to permit classification of soil losses on Muskingum silt loam in three divergence-from-contour classes, three slope-of-strip classes, and two classes under both length of watershed above the strip and percentage of watershed above the strip under cultivation.

Soil losses increased with increase in contour divergence, length of watershed above the strip, percentage of watershed above the strip under cultivation, and slope of the strip. No analysis of one of these factors independently of the others was made. The measurements on Westmoreland silt loam and Belmont silty clay loam, although too few to permit classification or analysis, indicated the losses that might be expected from cultivated strips on these soils.

In 1938 the 187,106 linear feet of strips measured yielded a sufficient number of samples to permit classification of the soil types into the following groups of like erodibility: Residual soils with light-textured or permeable subsoils, residual soils with moderate to heavy textured or compact subsoils, glacial soils with light-textured or permeable subsoils, and glacial soils with moderate to heavy textured or compact subsoils. Soil types showing no significant difference in erodibility were grouped in studies of the other factors affecting erosion.

Studies of soil losses from strips of different widths and different degrees of previous erosion showed that variation in the width of strips under 84 feet did not affect soil losses and that the greatest soil losses were from those strips on which previous erosion had been greatest. The data for study of the relation between soil loss from cultivated strips and land use on the watershed above the strip and the soil management on the strip-cropped field show that more soil was removed from a strip if the watershed above it was clean-cultivated than if it was under a cover of vegetation and that soil losses decreased with increase in the fertility level of a strip.

The data on losses from strips having different divergences, slope of strip, and length of watershed above the strip were sufficient to permit a study of the critical values of these factors.

It was presumed that a certain loss of soil from cultivated strips is permissible. Limits of permissible soil loss were arbitrarily designated, and values above which soil loss in excess of these limits would occur were termed "critical values" of the factors affecting erosion. The critical value for contour divergence on residual soils was found to be 5 percent. There were too few data to make a like determination of the critical value for contour divergence for glacial soils but the measurements available seemed to indicate that the critical value for contour divergence on these soils would also be 5 percent. The critical values for slope of strip and length of watershed above the strip were identical for soils within a group but varied between groups.

Practices supplementary to strip cropping that would seem to reduce soil losses are improvement in the fertility level and quality of the meadow strips, diversion terraces to break the effective length of slope above cultivated strips, sod waterways, high contour ridging of cultivated rows, and cultural practices on the watershed above a strip that provide a vegetal cover or other impediment to the free flow of water down a slope.

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